Dielectric Properties of Poly(ethylene-co-butylene) Modified MWCNT/Polypropylene Composites

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Introduction

The preparation of multi walled carbon nanotube (MWCNT) composites has received a substantial amount of attention during recent years. It is well known that functionalization of MWCNTs facilitates dispersion of the nanofiller in composite materials. However, there are few examples in the literature where the conductive properties of composites containing functionalized CNTs have been investigated. In these cases it has been shown that the functionalization has had a detrimental effect on the conductive properties of the composite.[1,2]

Here we present a method for functionalization of MWCNTs with poly(ethylene-co-butylene), which is a well known compatibilizer for polypropylene, though to our knowledge has not been used on MWCNTs.

The objective was to exploit the good properties of the compatibilizer to produce composites of functionalized MWCNTs with a relatively low degree of functionalization. The hypothesis was that good dispersion would still be obtainable due to the functionalization, while other properties such as conductive properties and potentially also mechanical improvements would not be substantially deteriorated or possibly even improved.

Methods and Materials

MWCNTs with an average diameter of 9.5 nm and average length of 1.5 μm were purchased from Nanocyl S. A. (Belgium). Poly(ethylene-*co*-butylene)-OH (M_n=7000 g/mol, Kraton Liquid Polymer L-1203) was acquired from Kuraray Co., Ltd. (Japan), all other chemicals were purchased from Sigma-Aldrich and used as received.

Results and Discussion

In the presented study a functionalization method based on nitrene chemistry, which is well known in functionalization of CNTs,[3] has been applied to obtain a low degree of functionalization of poly(ethylene-co-butylene) on an industrial grade MWCNT. For this purpose an azide functional poly(ethylene-co-butylene) was synthesized and coupled to the MWCNT as shown in Figure 1.

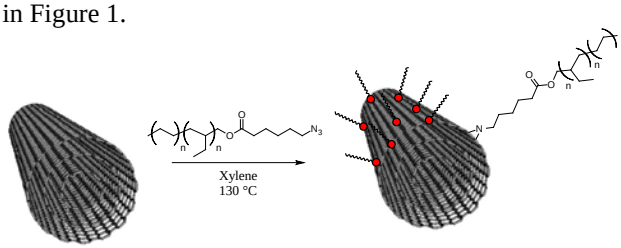

Figure 1: Preparation of Poly(ethylene-co-butylene) modified MWCNT (f-MWCNT).

The functionalization of the f-MWCNT was confirmed by both Raman spectroscopy as well as TGA. PP composites of both pristine as well as the f-MWCNT was prepared in a two step procedure, applying a new masterbatch procedure followed by extrusion on a miniextruder. The PP composites where prepared with a varied concentration of both pristine and f-MWCNT from 0.1 wt% to 1 wt%.

The composites were characterized by both rheology and dielectric resonance spectroscopy (DRS) to describe the extent of dispersion, effects of concentration as well as the conductive properties as shown in Figure 2 for DRS. The f-MWCNT/PP composite was found by DRS to have a percolation threshold below 0.3 wt%.

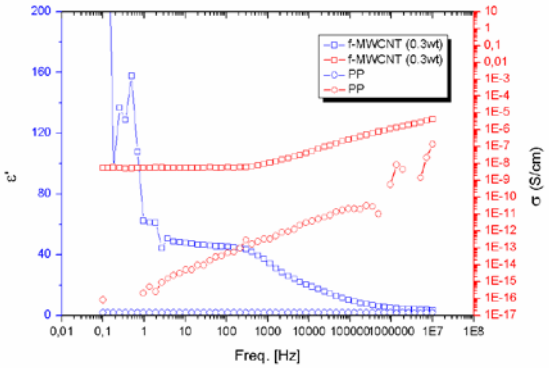

Figure 2: Dielectric resonance spectroscopy of f-MWCNT compared to PP.

Conclusions

A novel f-MWCNT/PP composite was prepared and investigated. Well dispersed materials were prepared through a masterbatch procedure. The f-MWCNT/PP composites were found to have conductivity comparable to the pristine MWCNT/PP. A low percolation threshold was identified for both the modified and unmodified materials.

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